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Proceedings of the Madras Government, Revenue Department, 17th February 1864.

Read the following letters :—

No. 251. From J. SILVER, Esq., Collector of Tinnevelly, to J. D. SIM, Esq, Secretary to Government, Revenue Department, Fort Saint George, dated Trichendoor, 2nd February 1864, No. 41.

SIR,

1. I have the honor to acknowledge the Order of Government, dated 14th January 1864, No. 75, transmitting seven papers for delivery to Captain Phipps, and directing that four of them being Dr. Kelaart's Reports on the Ceylon Pearl banks and the Natural History of the Pearl Oyster, be returned to Government after perusal.

2. The Superintendent of Pearl Banks is just now with me on the coast, for the purpose of examining the bank off Trichendoor, and discussing with me the subject of the proposed Oyster nursery shortly to be commenced. I have delivered to Captain Phipps the Reports by Mr. Vane and Mr. Twynam, and I return Dr. Kelaart's four Reports as requested, as Captain Phipps has already got copies of them.

No. 252. From JAMES SWAN, Esq., Colonial Secretary at Colombo, to the Chief Secretary to Government, Fort Saint George, dated Colombo, 30th January 1864, No. 4.

SIR,

Having laid before His Honor the Officer administering the Government, your letter No. 75A of the 14th instant, I am directed to acquaint you that there is no objection on the part of this Government to Dr. Kelaart's Reports being re-printed for distribution in the Madras Presidency.

Introductory Report on the Natural History of the Pearl Oyster of Ceylon.

1. Having understood that some account of my researches into the Natural History of the Pearl Oysters of Ceylon, is desirable, even at this early period of my labours, I shall endeavour briefly to sketch a Report, that can only be considered in the light of an Introduction to a more extensive and prolonged series of observations; which, if means are afforded me, may be brought to a more speedy conclusion than I have any prospect of doing at present.

2. Before I proceed to detail the results of my researches, since I was commissioned by His Excellency the Governor, in March last, to undertake this desirable investigation, I have to acknowledge the great facilities which the *aquarium* gives, for the investigation of the natural habits of Molluscs, and other moderately sized fresh and sea water animals. Without glass aquaria and a powerful microscope, I should not perhaps have obtained even that information on the minute anatomy and habits of the Pearl Oyster, which is embodied in this Introductory Report. Soon after my appointment, I ordered out large glass aquaria and other apparatus, which will be of service hereafter, to myself, or to those who may be engaged years hence, in reporting to Government, from time to time, the natural condition of the Oysters in their various banks. In the meantime, I have made use of large glass globes and Ceylon manufactured aquaria, made of thick crown glass, roman cement and slate, purchased from the Naval Stores. Large chatties too, and tubs, are also in use. The Oysters thrive best in chatties, but these do not afford the same opportunity of seeing their habits as glass sided aquaria. I have also, in addition to the abovenamed means of observation, had perforated wooden boxes, with a few Oysters in each, deposited in various depths of the sea; and latterly, I have used large canoes (ballams) for the same purpose;—lastly, though perhaps of most importance, I have had unexpected facilities of observation among the several small beds of Oysters, found in the inner Harbour of Trincomalie. They are found of all ages and sizes, at various depths, and different kinds of banks; so that no Naturalist has perhaps ever had the same opportunities of observing the habits of the Pearly Mollusc, as I have at present.

3. I cannot do better, than correct at the outset, some popular errors regarding the anatomy of the Pearl Oyster; and this I may perhaps do most simply, by describing, in a popular form,

the external and internal structure of the species of Mollusc producing the best Pearls of Ceylon.

4. The Mollusc, generally known as the Pearl Oyster, found in the Banks of Arripo, Chilaw, Trincomalie Harbour, and other parts of the Island, does not belong to the same *genus* as the edible Oyster of Europe, although, in its internal structure, it has a resemblance to it. The Pearl Mollusc resembles more the Mussel tribe than the Oyster; more particularly, as it has like the Mussel, a byssus or cable, by which it attaches itself to foreign substances, or to others of its kind. The only source of information that I know of on this subject, available to the Ceylon student, is to be found in "Lebeck's Account of the Pearl Fishery of Ceylon, 1797," to be seen in the Appendix to Captain Steuart's book. The description Mr. Lebeck gives, is very imperfect, and excites a smile in the modern Naturalist; but this imperfection is excusable, in any account written in the infancy of the science of Conchology, and when the Microscope was scarcely ever applied to anatomical studies of shells, at least not in Ceylon. The most glaring error in that description is the mistaking of "bluish spots" on the foot for "eyes," and the "ovaria" for "lungs." This Mollusc has no eyes; and the lungs, or gills, are in the front far away from the stomach, and occupy the middle space between the hinge and the anterior edge of the shell, easily seen when the valves are open; they look like four, or two pairs of whitish (in a few specimens the gills are of a black colour) semi-lunar combs or bands, stretched from side to side.

5. I have carefully examined Oysters of all ages, and have noted the structure of the shell, and of the animal within it; which will form the subject of illustration in a future Report. In this, I shall briefly describe the animal; as it is of the greatest importance, that a correct knowledge be first obtained of the animal structure, before a physiological account of its habits can be properly understood.

Meleagrina margaritifera. *Lamarck.*
The Pearl Oyster. *Pintadine mèreperle.*
Synonymes Mootoo Chepee. *Tamul, Sing.*
Mytilus margaritiferus. *Linn.*
Margarita sinensis. *Leach.*
Avicula margaritifera. *Roissy.*
Avicula meleagrina. *Blain.*
Avicula margaritifera. *Sowerby.*
Avicula radiata. *Leach.*

Conchologists have long agreed that *Lamarck* was right in separating the "Pearl Oyster," *par excellence*, from the old genus *Avicula*, of which there are several species in Ceylon, some producing valueless pearls of a dusky blue and blackish colour. The only description of the Pearl Oyster of Ceylon I have access to, is Lamarck's, in his "*Histoire Naturelle sans Vertebres*," and that, too, is only of the shell.

"*Meleagrina testa, subquadratâ, superné rotundatâ, fusco virente. Albo radiata, lamellis per series longitudinalis imbrecatis, superioribus majoribus.*"—Lamarck, vol. 7, p. 107.

6. The Ceylon shell is a variety of that above described. The white radiating lines are alternated with rays of a red or black colour. Doctor Templeton made it appear, that the Ceylon variety corresponded with Leach's description of his *Avicula radiata*. I am more inclined to believe that they are only accidental or occasional varieties. The shell, however, appears to attain a larger size in America, and in the Persian Gulph, than in the Seas of Ceylon. In the largest Ceylon shells, the red or black radiating lines become obsolete. If they are permanent varieties, they are both found in Ceylon. I have a faint recollection of having seen both varieties on the Pearl banks of Arripo. I had also a small perfectly white Pearl Oyster; this may be in Albino specimen, or Lamarck's *Meleagrina albina. M. testa albida irradiat, absoletè squamosâ; auriculus duabus semper distinctis*, originally found on the coasts of New Holland and Van Diemen's Land.

On removing the animal from the shell, the whole of the internal parts is seen enveloped in a membrano-muscular covering, called the "*mantle*," and known popularly in Ceylon as the "*skin*." The free border of the mantle lining each valve, dips downwards, to meet a similar veil on the opposite side; thus forming a kind of double fringed veil. The one set of tentacular fringe, in immediate contact with the shell, is composed of hairy tentacles, looking horizontally forwards the other, about three-eighths of an inch apart from the former, and lining the edge of the mantle, from side to side, looks downwards, and dove-tails with the tentacles of the opposite flap of the mantle. These tentacles consist of a series of long and short flat filaments—the long ones having lateral filamentous projections. The tentacles are exceedingly sensitive; and one would almost give them the power of seeing; for not only the touch of a feather, but the approach of one, when the animal is lively and in good health, makes them draw forwards, and perfectly shut out the intruder. As these molluscs have no organ of sight, I have no doubt that the delicate nerves which are distributed through the mantle and its tentacular processes, possess in some degree the sense answering to vision in other animals, as well as of touch; for an Oyster will be observed rapidly to close its valves on the approach to the aquarium of a lighted candle, or even the approach of a hand, or the shadow of a person, near the glass sides of a vessel in which it is confined. I should not, in a popular Report, advert to this physiological subject, but that the senses of the Oyster have a great deal to do with its habits, not only in the aquarium, but also in its native bed. Were it not for these delicate fringes surrounding the mantle, the softer parts of the Oyster would easily become the food of a host of carnivorous creatures, abounding in the sea; and many more Pearls would drop out of the shell; than do now with such sentinels at the entrance of its external rim. The mantle is the only organ the animal has for the formation of the shell; the increase of the lateral dimensions of which, and the formation of the pearly nacre, and Pearls, depending upon the condition of this important investment. If it is injured, the pearly matter is not secreted in such abundance over the shell, or if, by some cause, it becomes retracted, the shell does not grow rapidly, and the mother-of-pearl lining is jagged at the edge, and is not of the usual brilliant colour. However, its temporary retraction facilitates the ingress of sand and other irritating particles, which doubtless become the nuclei of many a Pearl, as will be hereafter observed. The forepart of the mantle is coloured and rayed like the shell. The colouring matter is secreted by glands found in these parts. This glandular secretion serves the purpose of increasing the lateral and longitudinal dimensions of the shell. It is after this is deposited, that the pearly secretion (nacre) is applied to the inner wall of the shell, which, concreting or solidifying, increases its thickness. The pearly fluid is secreted by nearly the whole external surface of the mantle. It will be thus clearly understood, that when a grain of sand or the larva of an insect is introduced between the mantle and shell, it will become covered over with the pearly secretion; which always going on, is augmented at the part where the foreign matter lies. This phenomenon I have detected with the aid of the Microscope, in its very earliest stage.

About one and a quarter inch from the rim of the shell, is seen a pair of gills, like four segments of a circle, or semilunar combs, stretching transversely from one side to the other, the convexity looking forwards. There is a vacant space between the concave surface of the gills and the body of the Oyster. The *adductor* muscle, called "*grizzle*," is now seen, covered over with a delicate membrane. This muscle is attached to the inner surface of the both shells. On one side (the left, when the Oyster is placed with the hinge next the observer,) is seen a short, conical, tubular, sharp-pointed prolongation; this is the terminal end of the intestines; it looks like a sharp-pointed claw. The intestine is short; leaving the stomach, it winds round the *adductor* muscle, and terminates, as I have just remarked, on the side opposite to where the mouth is placed. There is always an unclosed space, between the edges of the mantle, when the tentacles are brought together, admitting of the free passage of excrementitious matter; and it was through the same opening between the mantle, that I observed, on one occasion, the ova escape, in a cloudy stream, which continued to pass into the water for nearly 15 minutes. I failed to detect the immediate part of the animal through which the ova found their exit;

and I have not been able to detect a regular oviduct. The ovaria, when distended with ova, cover nearly the whole of the stomach, heart, and liver, and project even on the conical cæcal process of the stomach, and also on the base of the foot. The stomach is very small, placed in the centre of the liver; the œsophagus is very narrow, scarcely admitting a moderate sized probe; it is about 3 lines long. The mouth, situated near the hinge, behind the foot and byssus, is a horizontal slit, of about 3 lines in length, in the duplicature of the lower pair of labial palps. These palps are large, broad, truncated anteriorly, and rounded on the sides; the inner surface plaited, or rather grooved. The sense of feeling, or touch, is no doubt, by this rugose structure, greatly increased. The palps serve the animal as organs of touch, if not of taste; they also serve to collect food, and give the animal the power of rejecting indigestible particles of matter, or such substances as might prove injurious.

I have, through the Microscope, ascertained the kind of food Pearl Oysters live on. This consists of minute algæ or weeds, animalcules and shells, called Foraminifera. *Diatoms* also, those minute vegetable forms which can scarcely be detected with the naked eye, are found growing on the external surface of the shell; where a host of infusorial and microscopical objects likewise find a pasturage. So that the Oyster may be said to carry on its back, the food upon which it lives. The siliceous internal skeletons of these Diatoms, I have detected in the excrementitious matter of the Oyster. It will be a subject for future enquiry, whether any of these sharp pointed *skeletons* do not permeate the coats of the mantle, and thus become nuclei of Pearls. I have, on examination of "seedling" pearls, found the skeleton of a *Navicula*, (species of Diatom) among the *ova*; but whether this proceeded from the stomach of the animal, or got there by passing under the mantle, it was not possible for me to determine.

The Pearl Oyster, like other Bivalves, (Conchiferæ,) are all Monœceous, or rather hermaphrodites; though, properly speaking, they can neither be said to belong to one or two sexes.) for, with the exception of the presence of *ovaria* (or egg bags,) no other sexual organ has been yet discovered, Doctor Johnson, in his valuable work on Conchology, remarks on *Conchiferæ*, "that every individual is sufficient to its own felicity." But however correct this may be, regarding the feeling of sexual gratification, it is clearly established by M. Rudolph Wagner, that in some Acephalous bivalves, as likewise in *Tunicata, Gasteropods* and *Polyps*, the ovaries of some individuals contain a milky fluid, instead of *ova*; and that this milky fluid contains *spermatozoa*, (seminal animalcules). I have no to add the Pearl Oyster (Meleagrina Margaritifera) as another of the bivalves species of Mollusc, which has individuals with spermatozoa, or seminalfluid, in organs similar to those which in a larger number of individuals contain ova, or eggs. It will not, perhaps, be necessary further to discuss this important subject, than to remark, that the Native divers' idea, that, "*there are male and female Pearl Oysters,*" is not altogether fabulous. The important part which the male Oyster must play in the formation of banks of Oysters, is self-evident, if it can be clearly established, that the ova absolutely require the vivifying influence of a male fluid. I have not seen more than three or four individuals with this milky fluid, in 100 Oysters; nor have I yet satisfactorily made out any difference in the characters of the shells of the two supposed sexes. The Native divers' opinion quoted by Captain Steuart and Mr. Lebeck, viz., that "the large flat ones they call males, and those that are thick, concave, and vaulted, they call females or Peedoo Chippy," is not borne out by my microscopical observations. I found well formed ova in Oysters which were broad and flat. It is quite possible, however, that in the course of this investigation, some external marks may be discovered, by which the male Oyster can be distinguished from the female. From the very small number of males (about 3 to 100) to females, I can easily fancy, that if by some natural or artificial cause, the males are destroyed, the banks will not be enlarged; and that in time, they will become extinct; *i. e.*, supposing the majority of Naturalists are correct in their present view of the Dicœceous character of Oysters. It is just as likely, that Mr. Garner's opinion will ultimately prevail; viz., "that the organs called *ovaria*, do at certain periods, secrete the seminal fluid, which impregnates the ova contained in them; and is then discharged as an excretion by the oviducts." To this observation of Garner I have to oppose the fact, that not a trace of ova

was seen in the ovaria of the supposed male Pearl Oysters, which were distended with the milky fluid at the time when the ovaria of other Oysters were distended with ova.

8. The last, though not the least important part of the animal, is the foot. This important member, which has so many useful services to perform in acephalous molluscs, requires a more than ordinary consideration. It is that long, brown, leech-like member, which is seen when the animal is at rest, coiled up in a corner on the right side, above the byssus, which, when protruding out of the shell, and moving about, gives one the popular idea of a tongue. It is of a dark brown colour above, and whitish beneath; in middle age it is speckled. It is composed of longitudinal and transverse muscular fibres, the latter interlacing between the former, which proceed in two columnar masses from each side of the *adductor* muscle; between the bundles of fibres, are placed the abdominal viscera. From its base is sent off, posteriorly, a glistening white fibrous band; this is attached to the duplicature of the mantle, near the angle of the valves. Thus, the foot is seen to be admirably adapted for locomotive powers; and also serves, by its connection with the *adductor* muscle, to lengthen or shorten the cable or byssus. The foot, in a full sized Oyster, is about two and a half inches long when extended; at rest, it is not more than one and a half inch in length. It is broad at the base, tapering to a conical point; the upper surface is rounded and smooth, the lower flattened and grooved. The groove extending from the base, terminates at the point in an oval cup-like fosset. This groove is lined by a secreting membrane, and is an exact mould for the formation of the byssus, at the will of the animal. When it finds a necessity for making one, the foot is protruded out of the shell, and with the tip it seeks out a spot, where it can rest the terminal disc of the groove. If not satisfied with the substance or position of the stone or any other matter on which it rests, it removes to another more suitable spot; for a few minutes (say five or six, if the animal is strong) it rests, and is then retracted within the shell, leaving behind a strong fibre with an oval disc, of the form of the groove in the foot. This whitish fibre is attached to the base of the foot at one end, and to the rock, or to the shell of another Oyster, at the other. In a day or two, this fibre becomes of a bronzed greenish colour, and looks like hair, with a broad flattened oval root attached to the rock. This process is again and again repeated, at intervals of a few minutes, till a sufficiently strong cable is formed. In a large Oyster, removed from the sea, upwards of fifty such fibres form a thick strong cable or byssus, which is attached to the base of the foot by a bifurcated fleshy root. The animal cannot detach the byssus from the rock to which it is attached, but it has the power of casting it off its own body and leaving it behind, (like a ship letting slip her cable and anchor in a storm, and sailing off to sea) in order to make another byssus, either on the same rock, or on any other convenient place.

I observed all this process in the aquarium, at a very early period of my investigations; and was not surprised to find, that the Pearl Oyster having nearly the same organs as the Mussel, should form and reform its byssus. But I was agreeably satisfied in learning by these observations, that Captain Steuart, in his valuable and interesting Monograph on the Pearl Fisheries of Ceylon, was incorrect in denying to the Pearl Oyster this faculty. He states, that "*it is not believed that Pearl Oysters have the power to detach themselves, or to remove at their own will.*" I have not only satisfied myself, and many friends who have seen the Oysters in the aquaria which I have established, that the Pearl Oyster can detach or unmoor itself, but likewise that it walks away with its foot foremost, and the shell behind; and does not, as Captain Steuart observes, "*more with its hinges in advance.*" This "shuffling" movement alone attracted Captain Steuart's attention, but it is an unimportant one; as all bivalves without a byssus have it, and it is independent of the will of the animal, owing to the valves being opened and closed for the purpose of respiration. How imperfect must Captain Steuart, a candid inquirer, now say, have been his long observations, when the Oyster is seen, night after night, taking a walk round the inside of a chatty, or mounting the glass side of a vivarium, forming, here and there, a byssus. It is most unfortunate, that he and others should not have made these observations, which are so simple in their nature, but yet conclusive of the possibility "*of translating Pearl Oysters from their original rocky beds to other more convenient locations.*"

Who can tell what the results might have been, had Dr. Wright's views been carried out? I know of my medical brother's Report (made I believe in 1803), only from the brief notice taken of it in Mr. Boyd's observations, and quoted by Captain Steuart, in the Appendix to his work (page 53). Mr. Boyd's observations clearly indicate, that Dr. Wright proposed, some thirty years ago, the transplanting the animals to places convenient for fishing them, when they arrive at maturity. Either Dr. Wright did not observe the facility with which the Oyster reforms its byssus; or he was misunderstood by Mr. Boyd, who remarks further on, "that surely as the animal has not the power of regaining its adhesion, after it is once detached, it cannot, when once broken away from its attachment, fix itself again, and must either perish, or be carried away by the current."

Now, it is very gratifying to me to be able to speak positively on this subject; and this I do hopefully, as I have observed the Pearl Oyster detaching itself spontaneously from its old moorings, in a glass vivarium, and attaching itself to another part of the glass vessel, not once only; but have noticed, that some Oysters will go through this process a dozen times, in less than a month. In addition to the above related facts, I have successfully established a colony of Pearl Oysters near Fort Frederick, in the open sea, at various depths; and have also Oysters which have been living for several months in wooden boxes, finger glasses, glass globes, chatties, and large canoes, sunk in the sea. Some were thrown into the sea, after being removed from the inner harbour and kept in my house in chatties and tubs for two and three days. The byssus of most of them had been broken and torn from the rock. These they have cast off, and are now living attached to each other, and to pieces of coral, and to rocks, exposed to all the influences of the sea.

9. When an Oyster is first put into a vivarium, it sickens, *i. e.*, the mantle becomes retracted, and a collapseis observed;— in a few hours it revives, but, with few exceptions, it is on the third or fourth day, that the portion of byssus attached to the foot of the animal, is shaken or cast off, and the animal puts out its foot and forms another near the spot where it lies; or walks, by a snail-like motion of its foot, to, or up the side of the glass, to the level of the water, and there fixes itself. Some of the Oysters which were thrown into the sea, are now seen growing on the sides of rocks, four and five feet from the bottom.

I am not surprised at these results, for the edible Oysters, without a byssus, have been known for ages to bear translating with advantage. If Oysters in artificial beds in England can live and breed, I see no reason why the Pearl Oyster should not do the same, and, like the edible Oyster, yield a large revenue; or prove remunerative to private individuals, who may undertake the establishment of new banks.

10. I have one other subject, connected with the interior economy of the Pearl Oyster, to report upon; and which the microscope which Government aided me in procuring, has enable me to investigate very satisfactorily.

My observations commenced about the middle of March last; although I was not officially connected with the Ceylon Government till the 1st of May. I have ever since made monthly observations regarding the fecundation of Oysters; with the following results. In March, and all through April, May and June, every Oyster I opened, young and old, contained ova in the ovaria, except the few which had the seminal milky fluid; so that the *Meleagrina*, like the edible Oyster is in spawn almost from its birth. A precocity serving a useful purpose no doubt; and its practical bearing easily understood. From July to the present date, the Oysters examined did not all contain ova; some of the ovaria were only half full; others contained a very small quantity. It will be very interesting to proceed with these monthly examinations, and to ascertain, whether the Oyster is only in spawn at certain periods of the year; and, if possible, to determine whether it spawns more than once in twelve-months. Nearly all the 100 Oysters from the Pearl Banks of Arripo, kindly sent to me by Mr. Vane, contained ova, their form preserved, although saturated with arrack. Under the microscope the ovum is seen to be pear-shaped; each measured $\frac{3}{1000}$ part of an inch in diameter, at its broadest part; longitudinally it is $\frac{6}{1000}$ with a short pedicle attached. I have calculated, with the micrometer, the number of eggs contained in the ovaria of an Oyster of five or six years of age, and I find that there cannot be less than twelve millions. Leuwenhook states, that ten million eggs exists in one European edible Oyster. If we consider how few of these millions of eggs can arrive at the mature condition of a living Oyster, and the great demand that man makes upon the species for his gratification; we can only see in this great fact, the bountiful provision made by the Creator for a wise and beneficial purpose.

11. In concluding this first Report, I shall briefly recapitulate the important discoveries I have already made.

1st. The Pearl Oyster is more tenacious of life, than any bivalve Mollusc I am acquainted with. It can live even in brackish water, and in places so shallow, that it must be exposed for three or four hours daily to the sun, and other atmospheric influences.

2nd. That it has locomotive powers, beyond any idea which can be formed from former observations.

3rd. That the power of moving from place to place, is inherent, and absolutely necessa ry in early life, for the due performance of the animal functions. This is obvious from the fact, that if a cluster of young Oysters stayed permanently in one place, adhering to each other, the growth of the animal, and particularly of its shell, would be prevented.

4th. That the Pearl Oyster will move about in search of food, if the locality in which it is originally placed is not rich in its natural supplies.

5th. That it will move from its original situation, if the water becomes impure, either from the decomposition of vegetable or animal matter, or muddy; and, probably too, if there is a large influx of fresh water.

6th. That if the water is agitated to an inordinate degree, the Oyster will leave its old mooring place and seek another.

7th. That a thunder storm will kill some in an aquarium. (Query, if thunder storms have similar fatal effects on Oysters lying deep in the sea?)

8th. That the animal can unfix itself from its byssus; and that crabs, shrimps, and other creatures, force them to form a new byssus, by nibbling through the old one.

9th. That it can re-form its byssus at pleasure, if in good health and condition.

10th. That it can live for a long time, without forming a byssus; and that it will re-form a byssus when it has recovered its strength:

11th. That the power of re-forming its byssus, is not confined to the young animal; but that the largest living Oyster I have seen, can re-form it in an aquarium, as well as in the depths of the sea, but not so actively as the young and middle aged.

12th. Pearl Oysters are gregarious in their habits. In placing several young Oysters in different parts of an aquarium, they will sooner or later be found attached to each other. The older ones have also this desire; but their heavy shells impede their motion, and they are contented to remain apart from their fellows.

13th. That taking the foregoing facts into account, there appears to be no reason why Pearl Oysters should not be translated from their native beds, and made to colonize other par ts of the sea.

14th. That the young, as well as the old, are in spawn from March to September; and that probably there is no stated period for spawning.

15th. The whole occupation of the Oyster, when fixed to a spot, appears to be, keeping its valves open, and admitting food to its mouth. For several hours the valves remain open, they then close for a few minutes, or for an hour or two, then open again. At night, the valves remain generally open till towards daylight, then they close, and remain so till the sun shines brightly over the horizon. It is during the early part of the night, or soon after sunset, that they exercise, *when required*, their locomotive powers. I have watched the Oysters in aquaria for nearly a whole night; and they appear to be then active in moving and attaching themselves to new localities. During the day, I have only seen, on one occasion, an Oyster form a new byssus. This nocturnal habit, is doubtless an instinctive precaution; for should Oysters move

during the day, they are more likely to become the food of fishes, and other animals which prey upon them. Their movements are instinctive, and guided by the sense of touch. Darkness suits them better than daylight, of the difference of which they are very sensitive.

16th. Most of the Oysters in which I have found Pearls, had external marks of having been retarded in their lateral growth, and displaced in early life from their fixed position on a bank. I am inclined to believe, that Oysters which have abundance of food, and are not disturbed, remain fixed for the last two or three years of their growth to one spot. These are less likely to have a large proportion of pearl bearing individuals among them. This of course requires more extensive practical observation, either on the beds in the harbour of Trincomalie, or on the Pearl banks of Arripo.

17th. With reference to the formation of Pearls, I have nothing new to add to the accounts found in the best modern books on the subject; except that one, which modifies the view taken by Sir E. Home; viz., that Pearls are formed from abortive ova. I believe the ova left behind in the ovaria, are not the nuclei of Pearls, but that the ova which escape through the distended coats of an overgrown ovarium, and are imbeded in the interstices of the mantle, become nuclei of Pearls formed in this situation. I have repeatedly examined seed, or young pearls, in process of formation; and with a magnifying power of 1-5 inch lens, I was able to see distinctly, the outlines of two and three ova through the first or superficial layer of nacre, surrounded by groups of ova. It can be readily understood how an overcharged ovarium will, by some accident, or spontaneous evolution, have its coats ruptured, allowing the ova to escape and become inserted in the contiguous attenuated parts of the mantle. As Pearls are more usually found imbeded in the mantle near the hinge, the most likely place where the ovarium is liable to rupture, I consider this very conclusive of the new theory I have here proposed. I may also observe, that I have seen the vestiges, or cicatrices, in the mantle where the Pearls once existed. Though Pearls originate in the mantle, when large they work their way out, and lie loose between it and the shell; or become attached to the "Mother-of-pearl" surface of the latter. I have no doubt that Pearls can work their way out from this position, and be found entangled in the meshes of the byssus. I also consider it very possible, that an overdistended ovarium is one of the causes of Pearls being discharged from the Oyster and lost. If this be really the case, it will easily account for the singular fact, that a sample of Oysters, fished in the month of October, will yield a larger proportion of Pearls, than a batch of Oysters fished from the same bank in the months of April and May of the following year. These observations are somewhat suggestive, and can be improved upon by future investigation.

12. I have now drawn to a conclusion this Report, which, I fear, has extended to a greater length than will suit the patience of the reader. But the subject being one which has been so long neglected and so little understood, I hope that the Government which has engaged my services, if they do not consider my endeavours as already productive of some practical results, will, at least, see in these researches, glimpses of future success. It is due to Sir Henry Ward, here to acknowledge my grateful thanks, in which my brother Naturalists in all parts of the world, will, I am sure, join, for the gracious manner in which my humble services have been retained, for investigating, fundamentally and practically, the Natural History of a species of shells, which from the darkest ages of the world to the present, has been considered of inestimable value in producing one of the richest of gems. Time was, when the product of Pearl Oyster fisheries founded cities in South America and the Red Sea. But what is the state of the Islands of the Red Sea, "whose merchants were Princes"?—They are now thinly inhabited by a miserable race of fishermen. The cites of some of the Oyster banks in South America are not even now known; they have been destroyed by being overfished. New beds are doubtless forming in localities to be yet known to future generations. Ceylon Pearl banks were once on the point of sinking into the same fate, but for the subsequent observance of more caution. I was present at two of the largest fisheries ever made off Arripo in 1835 and 1836. The Oysters fished during the first half of the fishery were full sized, and yielded a good price, most of the speculators making handsome profits. Government was encouraged to pursue the fishery; young Oysters

were taken up; many of the purchasers, inflated with former gains, purchased readily, and were ruined; and, I believe, to this day, these over, or prematurely, fished banks, have not been very productive; although twenty years have since elapsed. If the same incautious and unscientific plan were adopted on the Oyster banks in England, similar results would soon be perceived there Not a "Native" would be had in London, nor even a cultivated one seen any where. If Government desires to have a steady, and not a precarious revenue, from Pearl Oyster fisheries, let good laws protect the beds already known, and those that are now forming; and let means be adopted to secure their increase and growth. In one year more Oysters are consumed in England, than were fished on the banks of Arripo last year; and this consumption is repeated year after year, without exhaustion; simply because the natural laws having been once found out, they are allowed to operate fairly. It will indeed be a very great source of satisfaction to me, if any of the natural laws I have described in this Report, suggest to Government, an improved system of management.

13. My attention has also been directed to the natural History of the Tamblegam Oyster, *Placuna placenta*. I have a few still alive, which were translated in May last. If this Oyster can be successfully translated, the whole of Batticaloa lake might be converted into a large Ostrearium. *Placuna placenta* has no byssus, and can, therefore, be more readily transported. Their removal from their native beds, does not necessarily destroy the internal parts. About one-third of the Pearl Oyster *Meleagriana*, dio from being injured by the force necessarily applied when detaching them from the rocks to which they adhere.

14. I have also lately "*doctored*" some Pearl Oysters, according to the plan adopted by the Chinese, in the case of the large fresh water mussel; but which method, I believe, has never been attempted with the real Pearl Oysters. Time and further experience are required to ascertain the results of this practice in Ceylon. Dr. Gray, of the British Museum, has, I believe, by the application of the same means, succeeded in producing Pearls in the edible Mussel or Oyster of England. It may therefore be hoped, that I shall eventually succeed with the Pearl Oyster of Ceylon. All that I can at present say, is that they do not die under the operation, and that they are still living, having also reformed new byssuses. This is the only way the period required for the formation of good sized Pearls can be ascertained. There are some other points in the natural habits of the Pearl Oyster, which I reserve for future Reports; as precipitate conclusions may mislead the Government.

Trincomalie,
24th September 1857.

E. F. KELAART, M. D.,
Fellow of the Linnæan Society.

Report on the Tamblegam Pearl Oyster Fishery.

The Oyster found in the Tamblegam lake, and from which Pearls are obtained, is the *Placuna placenta*, "Vitre Chinoise" of some French writers, and the "Window Oyster" of English travellers in China,—the shells, from their semi-transparency, being used for windows. The *Placuna* belongs to the same family of Conchiferous Molluscs as the edible Oysters of Europe and of this country. It has no resemblance (except slightly in the animal structure) to the shells of the Arripo Oyster *Meleagrina*. When full grown, the valves (shells) measure, at their broadest transverse diameter, from 6 to 7 inches; and their longest longitudinal diameter is about the same; some, half an inch more. They arrive at maturity sooner than the *Meleagrina margaritifera*, and like the Arripo Pearl Oyster, the young also have ova. I am not able from my own observation (having been only a few months engaged in these researches) to say, in how many years this Oyster arrives at perfection. But from the appearance of shells of all sizes, and the history of the Tamblegam Pearl fisheries since 1839, I should say, that in three years, this bivalve Mollusc attains its adult age; and, that after that, it dies. It appears to thrive best in brackish water, but a large influx of fresh water (from rivers) kills them. Instances have been known, when a large number of young and old Oysters died in Tamblegam lake, during some very rainy seasons, when the rivers which empty into the lake brought down an unusual quantity of fresh water. If ever the channel, which was once proposed to be cut through the neck

of land which connects the lake with the Trincomalie harbour, is made, this cause of mortality will more rarely occur, perhaps never again exist.

From the flattened formation of the shells, Pearls are very liable to drop out when the animal reaches its full growth ; I would therefore fix, as the best period for fishing, the time when the animal has closed its supposed two years' age, or when the shell measures from 5½ to 6 inches in transverse diameter.

I have inspected the Tamblegam bank this week, and am sorry to report, that there is no prospect of even an average good fishery before the middle of 1859. The banks have been over-fished. The Natcha Cooda bank is completely destroyed. The renter in 1856, left scarcely any Oysters behind, and this portion of the bank will, consequently, be unproductive for many years; possibly never again, unless Government should re-stock it.

Nothing could have been more prejudicial to the interests of the Government, than to have leased out the bank by the year. The Government Agents who could have acted so unwisely as to lease out to native renters a small bank of Pearl Oysters for three consecutive years, without any stipulation as to the *size* of the Oysters to be fished, must have lost sight of the natural laws of re-production and multiplication of species, known even to the Native divers. It is therefore very gratifying to observe, that the present Government Agent, Mr. Morris, takes great interest in my researches ; that he is alive to the importance of the Naturalist's opinion, and has recommended that all young Oysters be thrown back into the lake ; a measure which I had the opportunity of suggesting to His Excellency the Governor in March last, but which, I believe, was only partially acted upon, during the last Pearl fishery at Arripo.

I watched the number of Oysters fished during the two days I was lately at Tamblegam (Keenear), and have to report, that there could not have been less than 30,000, on each day. More than two-thirds of this number were young, and had better have been left in the lake for another year or more. The renter is evidently making the most of the few months he has yet liberty to fish, or *rather ruin the bank*. The Tamblegam Wanniah, and all the divers, whom I questioned on the subject, stated, that in the early part of the present year more than 50,000 Oysters were fished daily. It is therefore impossible to arrive at any other conclusion, than that the former renters mis-represented the state of their finances, from the Pearl banks, when they got Government to remit some portion of the rent, and had the fishery re-sold for a smaller sum, to an other native,—a relative, I am informed, of one of the original renters.

All Oysters are very prolific, and the *Placuna* is not an exception to the rule ; for, at the lowest calculation, in three years, there must have been fished from this bank, upwards of 18 millions of Oysters, supposing that there were *only* 200 fishing days in each year. The renters' share must have been (allowing five shillings for each thousand Oysters) nearly £2,250, from which, deducting the three years' rent, viz., £901, they must have derived a profit of at least £1,250. To this profit must be added another source of gain, (a very ingenious one) from the divers' share of Oysters. The diver is allowed half the quantity fished, but he is not permitted *to sell* the Oyster at the best market, or to the highest bidder. He is obliged to open the Oysters when fresh, and sell to the renter all the Pearls, at a fixed rate, which the renter takes good care shall be below the market value. Any plan therefore, which may relieve the diver of this grievance, will, I am sure, be thankfully welcomed by at least 200 individuals, whose chief means of living is by diving for Pearl Oysters.

Oysters of upwards of two years of age, (*i. e.* about six inches broad) are worth *at least* ten shillings a thousand, but if there is any competition, they may be sold for even fifteen shillings a thousand ; for although the Pearls they produce are about two-thirds less in value than those from the Arripo Pearl Oyster, *(Meleagrina)*, the quantity obtained in 1,000 Oysters, is at least three times more than what is obtained in a similar number from the Arripo banks.

Upon these considerations, I have to submit for the future guidance of Government, the following proposals :—

1st. That the banks be allowed to remain undisturbed for 18 months after the termination of the present fishery.

2nd. That future fisheries be conducted by Government Officers, and the Oysters sold to the highest bidder.

3rd. That the fishery be held only for two or three months in the year ; say April, May and June, and that a sufficient number of boats be employed daily, so as to have the matured Oysters fished during this period.

4th. That the banks be carefully watched, and placed under the immediate supervision of the Tamblegam Modliar, to whom a per centage might be promised on the net profits of each fishery which yields to Government more than £500. I suggest this per centage, well knowing, that any extra work thus thrown upon a native official, will be badly performed, unless paid for according to the value of his labour.

5th. That no Oyster under 5½ inches broad, be allowed to be removed from the banks.

6th. That a fourth share of the Oysters fished be *bonâ fide* the divers' share, which they shall be at liberty to dispose of to the best advantage for themselves.

7th. That those parts of the Tamblegam lake which have been denuded of Oysters by overfishing, be re-stocked with young Oysters, found in the shallow parts of the lake, or near its margin ; which if left in their present position, are very likely to be clandestinely removed at night, although the banks may be strictly watched.

8th. That Government endeavour to fish up the Oysters by dredging, instead of the present pernicious method of divers walking over most parts of the bank, searching for them with their feet ; by which means, they crush the young Oysters and destroy the spawn.

This Oyster, having no byssus, is not attached to any hard substance ; nor is it cemented, like some of the edible Oysters, by the hinge, or by one of the valves, to any object, but lies either flat on the mud, or is fixed loosely in a semi-vertical position, with the wedge-shaped hinge buried in the mud. It follows, therefore, that they can be removed with great facility with the ordinary Oyster dredge.

The young Oysters taken up by the dredge can be returned immediately to the lake ; or collected and then deposited in some suitable place, previously selected by the supervisor.

I have no doubt, in my own mind, that by proper supervision and care, the Tamblegam lake Oyster Fishery, may be made to yield in a few years, at least, £1,500 every second year. For the last 18 years, the average annual revenue to Government was only £314.

In order to secure this revenue for future years, it is necessary that the present renter's proceedings be watched ; and, that he be obliged strictly to observe the condition of his bond, viz. : " That the Fishery of the said Pearl banks shall be *carefully* and *providently* carried on by the Renter and others, his servants, so as to cause no *damage* or *injury* to the said Pearl banks."

If, in the opinion of the Government, the above condition does not enjoin the renter to prevent divers taking up *young* Oysters, I think it will be worth while to pay him £50 or more, and take his lease from him ; for, at the rate he is now fishing and bringing up daily 5,000 or 6,000 young Oysters, scarcely more than eight months old, and which cannot yield more than six-pence worth of Pearl in each thousand, even if they do that, the bank, which now promises to give a tolerably good fishery in June 1859, may, like the Natcha Cooda bank, be unproductive for many years. I would therefore suggest, that a Government Officer be immediately sent to the fishery to prevent further mischief being done.

I cannot help again observing in this Report, that it is worthy the attention of Government, to stock the various salt lakes of Ceylon with this species of Oyster. The lakes of Calpentyn, Putlam, Batticaloa and Hambantotte, if stocked with the "Window Oyster," will yield a very handsome revenue. I have availed myself of the present opportunity to remove about 1,200 middle-aged Oysters (which the renter gave me) to *Yard Cove* in Trincomalie harbour, where the muddy bottom promises to be suitable for breeding them. But the experiment should be made on a larger scale, to test the full value of translating these Oysters to new localities ; this I am not able to do from want of funds to meet the necessary expenses. I have already, in my

former Report on the Natural History of Pearl Oysters, reported, that some of the Oysters, which were placed in other parts of the sea in May last, are still living.

Trincomalie,
3rd October 1857. (Signed) E. F. KELAART, M. D.

Report on the Pearl Banks of Arripo for season 1858, *by* E. F. KELAART, M. D. F. L. S.

Having concluded my researches for this season, on the Pearl Banks of Arripo, I have the honor to submit the following report to His Excellency the Governor.

The Condatchy Bank, which was reported to contain, last year, large quantity of Oysters in shallow water, (three fathoms), does not at present contain many matured Oysters. A few only of a middle size are found there. But in deeper water, near the former bed, Oysters of various sizes are found in small clusters on stones, and a few large ones, attached to sea weeds. This looks as if the Oyters are spreading into deep parts of the sea. There not being sufficient quantity of large Oysters in this Bank, I have not been able to determine what quantities of pearls these Oysters yield. One out of about twelve opened, contained a few small pearls.

A few small Oysters are found scattered in various parts of the sea, in all depths. But it will be years, before large beds can be formed from these scattered ones.

The Cheval Paar Bank, fished this year, has, in my opinion Oysters of two different ages, but so intermixed one with the other, that it is impossible to fish for the larger, without bringing up also the smaller ones. The proportion of small to large ones, is, in some part of the banks, 1 to 3, in other parts as 1 to 2.

I totally differ in opinion from the Adigar of Manaar as to this large number of small Oysters being of the same age as the larger ones. His comparison of them to "small men and women, and large men and women, though of the same ages," may hold good in few cases. But when we find so large a proportion of Oysters, whose shells and internal parts positively demonstrate their youth, I am certainly disposed to place more confidence in my own opinion, and that of the Maniagar of Jaffna, and natives who are purchasers of the Oysters, viz., that the Oysters found in this bed, are of more than one age. The Oysters whose growth has been stunted, have very different characters;— their shells are thick, and there is not the same length of pliable edge, which young Oysters have; the adductor muscle and other parts of the Oyster bear also the marks of age. The muscle is hard and stouter, in the adult, and further removed from the hinge; the foot is firmer and more speckled, and the groove under the foot is irregular; the liver cuts firmer; and the nacreous part of the shell has a thick edge in the adult Oyster.

The fact that good Pearls are also found in these second sized Oysters, does not show, that they are as old as the larger ones. There are other causes which doubtless come into operation here, part of which only can, in this second stage of my inquiry, be demonstrated. The presence of a worm (a species of Filaria) found in the Oysters, has, I am positive, much to do with the formation of Pearls. I would rather reserve this part of my investigation for longer experience. But this much I can say at present, with perfect safety; that whenever I found good pearls in a batch of Oysters, I found this worm and its eggs in large numbers in the liver, ovary, mantle, and other parts of the Oyster.

My researches here, have quite proved to me, and will also prove to others, who will carefully and without prejudice examine for themselves, that the ova of the Oysters and the ova of worms, form the nuclei of many pearls found in the soft parts of the animal; and that sand, portions of sea weed, larva of insects, &c., form the nuclei of the shell pearls, or pearls attached to the shell. I have specimens demonstrating this even to the naked eye.

It was the celebrated Sir Everard Home, who, I believe, first started the doctrine of eggs being the nuclei of pearls. But this theory has been contradicted by other writers. I have however, in my Report of last year, stated how escaped ova could readily form such nuclei, and now I have the pleasure of announcing to the scientific world that I found the ovaries of a Pearl oyster filled with pearls of various size and shape. I have preserved the specimen for transmission

to Professor Owen, to be by him placed on the shelves of the Museum of the Royal College of Surgeons as a proof of the accuracy of the late Sir Everard Home's doctrine, which has for many years been exploded. I obtained from one of the ovaries as many as thirty-two pearls, and the other egg bag, still unopened, seems to contain as many more. It will now indeed be a curious question, where the pearly matter forming the pearl found in the ovaries was derived from. Sections of these pearls shew the same form of nuclei as pearls found in some parts of the mantle; and the large irregular ones, have more than one such nucleus. The mantle was found adhering to the ovaries as if it was the result of adhesive inflammation. And as the mantle is acknowledged to be the secreting organ of pearly matter, could this matter have been introduced into the ovaries? or is it likely that other parts of the Oysters, such as the walls of the ovaries, occasionally secrete pearly matter under abnormal circumstances? It will be premature now to decide upon this interesting physiological subject.

The Modregam Bank, which is intended for fishing next year, contains Oysters in clusters of three, four or five, attached to each other. In most parts of the bank, the clusters are formed of Oysters of the same size, but in other parts, Oysters of various sizes are clustered together. In one or two places, very small Oysters adhere to larger ones; some of these small Oysters could not be more than a few months' old. This is a very favorable sign. Very rarely, indeed, was a young Oyster fished up this year in the Cheval Paar Bank. This difference leads us to an inquiry of a very practical nature, which may perhaps require years for its solution; viz., why there are so few young Oysters in the old banks? What became of the spawn which even middle sized or young Oysters certainly have? Are the spawn of young Oysters of speedy decay. Analogy leads me to think that the progeny of the old Oysters are more likely to reach maturity. This indeed will form the subject of further inquiry, particularly as in banks, in shallow water, Oysters of all ages are found together. It is reported to me, that some years since, the clusters found in the Modregam Bank were formed of more Oysters. If so, it is natural to conclude, that as Oysters grow large, they detach themselves and form smaller clusters. Their faculty of doing this, I have proved by my investigation in Trincomalie, which is recorded in my Report of last year The larger Oysters of the Modregam Bank are at the present moment, of about the same size as those fished this year from the Cheval Paar, but there are other marks of difference of age about them, which make me inclined to believe that they are younger than the larger sized Oysters found in the Cheval Paar. The shells of the generality of them, although broad and long, are very thin. These Oysters also have the worm abovementioned. But I have not been able, as there is no fishery of this bank, to open a sufficient number, to ascertain what is the relative proportion of pearls to the worms found. The pearls I have found in these Oysters are in general small, less irregular shaped, of a whiter and more brilliant luster than the pearls found in the Cheval Paar Oysters. The Superintendent of the Pearl Banks has washed 5 or 6,000 of these Oysters, but I have not yet ascertained the result of this washing.

Had there been inspections by the Inspectors, of other parts of the sea during my stay here, I could perhaps have ascertained many other facts. But as the Inspector has neither time, nor can I, single handed, without boats find out other banks with Oysters, I must hope for other opportunities. It would have been more satisfactory to have extended my researches to large banks with *smaller* Oysters than at present found in the Cheval Paar and Modregam, but as there are no such banks known, even to the Inspectors or Native headman, my observations have been so far limited. But as I hope that Captain Higgs and his Assistants will bring to light other banks before next year's fishery, I may have the opportunity then of completing my researches, and bringing them to a conclusion.

I cannot close this Report without expressing my thankful acknowledgment for the facilities offered to me (for making these researches) by Mr. Vane, Captain Higgs, and other Officers connected with the Pearl fishery.

I have thought it necessary to make certain suggestions to the Superintendent of the Pearl Fishery for the better preservation of the Pearl Oyster banks, which I had already the honor of communicating to the Honorable the Colonial Secretary for the information of the

Ceylon Government. The unfortunate visitation of Providence (prevalence of Cholera among the divers) has closed the fishery sooner than expected; but it is to be hoped that as some large portions of the bank have not been fished at all, and there are many young Oysters among the older ones, Government will be able to have a small fishery next year on this bank. For further information on this subject I have to refer to my former Reports.

(Signed) E. F. KELAART, M. D.

Suggestions for the better preservation of Pearl Oysters, by DR. E. F. KELAART.

Being convinced from what I have seen, heard, and read on the subject of Pearl Banks, that the method of fishing them from one end to the other, and only leaving small patches, or detached masses behind, is not the most likely one of keeping up the breed of Oysters, or rather of encouraging the formation of banks worth fishing, or from whence even a moderate revenue could be derived, I have, therefore, advised Mr. Vane, the Superintendent of the Pearl Banks, to reserve a portion of the bank, say about half a day's fishing, for breeding purposes; in fact, to do that as a rule, which he, to use his own words, "unwillingly" did last year. Owing to bad weather and other causes, the fishing was brought to a conclusion sooner than intended, and consequently, a tolerably large part of the bank was left unfished.

As Mr. Vane and Captain Higgs, the Inspector, while agreeing to do what I recommended, have thought proper to record their dissent from my opinion on this subject, I shall briefly give, in writing, my reasons for making this proposal, as I have already done verbally to the Superintendent and Inspector, I regret to say, without convincing them.

It is my opinion, and that also of abler men, that while Oysters have no sexual differences, the ovaria of some secrete a seminal fluid, and that this fluid is the fertilizing fluid; or, to use a popular phrase, there are male and female Oysters; and as I have found the former bear a very small proportion to the latter, having frequently examined 50 Oysters without finding a single one with the seminal fluid, I believe therefore, that the chances of females reaching the influence of males, will be far greater in a large portion of Oysters than in small ones.

Supposing even the fertilized ova are formed in small clusters of Oysters, such as those which Captain Higgs and others allow to remain in the banks after fishing for the season, these eggs, comparatively small in number, are likely to be drifted about in various directions, their contiguity destroyed, and they are likely to settle down in small numbers in various parts of the sea; but it may take many years, till the patience of Government is exhausted, before, by the aggregation of small clusters, a large bank be formed out of these small original elements. The contrary is observed, when the ova proceed from a large area,—the spawn is seen floating in hundreds of yards, and wherever it settles large banks must be formed; and the history of the banks now being fished, and the one to be fished next year, show that they were formed by large deposits of Oyster spawn, and not by the gradual introduction of small quantities. When the condition of the small banks of Trincomalie is compared with that of the larger banks of Arripo, the cause of the difference is very evident.

There have been for years no deposits of spawn in large masses in these waters; and why? Because for years these banks have been fished on the old plan, a plan older than the period when Cleopatra obtained the famous Pearl, and under which plan and regimen the banks of the Red Sea, North America and India failed, and are now mere matters of history. And, I must add, that under this plan the Negombo, Chilaw, and Calpentyn banks were lost to the Ceylon Government, and this plan, long pursued by Captain Steuart, terminated in the failure of the fisheries at Arripo for nearly twenty years. Would it do now, when science has thrown some new light on the subject, to persist in what is objectionable? Captain Higgs may say, he leaves a sufficient number of Oysters, perhaps even a larger number than that which can be found in the patch which he has reluctantly spared for this year; but in what condition will he leave the small clusters? In a condition any thing but natural. It is true, that the Oysters I have shown him were in spawn, but he did not wait until I could explain to him under what conditions the Oyster spawn could come to maturity, or become fertilized.

I have reason to believe, that the injury done to the bank by the divers, and the anchors of their boats, has a fatal effect, from which it does not recover for years.

In my former Report, I stated that the Oysters will die, if the water is impure. Now, let us examine what takes place, when the divers have kicked, splashed, and torn every thing before them while in the water. Not only do some Oysters left behind die immediately, but other Molluscs, Zoophytes and sea weeds die, and must necessarily stagnate the water at the bottom of the sea. The result of all this must be, the gradual dying off, not only of the old Oysters left on the bank, but also of the young. I have seen sufficient numbers of fresh dead Oysters brought up, from that portion of this year's bank already fished, to show what the higher rate of mortality must be in a very short time. Captain Higgs, in his letter to the Superintendent states, that the Oysters I thought had died since the fishery began, looked as if they had been recently opened. The matter is too serious to remain uncommented on, and I take this opportunity of giving the *post mortem* appearances of gradual decay of Oysters, and those dead from death caused by the divers or other men in the boat, killing an Oyster with the hope of obtaining pearls. When an Oyster dies, the two valves of the shell remain for months united at the hinge. When an Oyster is opened, the valves are disunited. The so-called recently opened shells, brought up from the fished part of the Pearl banks, had all the shells with the valves united at the hinge; a few were separated by me after they were brought into the boat.

I have recently gone through most part of the bank fished last year, in company with the Maniagar of Jaffna, and was not surprised to find grounds of Oyster shells of all sizes, and dead shells of so young Oysters as to be considered of one or two years' growth. From amid this wreck and ruin, the divers brought up occasionally a large live Oyster, but no small ones. But on coming to that part of the bank which was "unwillingly" left unfished last year, the Oysters were alive and in good condition, and very rarely was a dead shell brought up.

I have also gone through many of the parts of this year's banks, and found, wherever the divers have been, there were many dead shells, and only a few dead ones were obtained from those parts which have not yet been fished.

The above facts require no further comment from me in this Report, and I shall, therefore, draw to a conclusion, hoping that the adoption of my suggestions will be approved of by the Ceylon Government, especially, as the loss to the revenue by reserving a part of the bank, can be made up by sending a large number of boats, again and again, over the fished parts, but which perhaps will not be found necessary, after so very handsome a return as is expected this year. I only claim for the future interests of Government, the observance of those natural laws of God, a part only of which, He has permitted man to know, and which, when known, it is but just that we observe them, especially, when any natural production is required, year after year, for economical or ornamental purposes. I need scarcely remind the reader, that the non-observance of such laws has before this brought down its own punishment in other matters than Pearl Oysters.

When we examine the old method pursued in Pearl fisheries, we must acknowledge it to be sadly defective, as too much is left to the divers and the interests of native Headmen. Sixty or more boats, manned by 10 divers each, are sent on a bank to dive for Oysters. The diverse go on, from day to day, fishing up Oysters from one end of the bank to the other, and after the whole bank is gone through, a larger number of boats are employed for two or more days to go over the bank again, and it is only when the boats do not bring up a remunerative quantity, that the fishery is closed. By this method the quantity of Oysters left cannot be regulated. It all depends on the diver's exertion. In some fisheries, a large number may in the aggregate, be left in small patches, or single ones widely scattered. But it may happen, sometimes, that very few are left. The quantity cannot be well regulated by the Inspector or his Assistants, for all the information is got from the divers, who are interested in giving a false impression. Whereas, by buoying out a portion of the bank at the commencement of the Fishery, the Inspector can calculate, almost to a nicety, the quantity he reserves for reproductive purposes. Surely, it is not too much to claim for this wise purpose, 1-40th portion of the bank.

For the sake of meeting the objection of some to my plan, on the score that I cannot be sure of the spawn proceeding from one bank being deposited on the banks of Arripo, I would ask them, where did the spawn which formed the Oyster banks of Arripo come from? The answer given, is, I believe, that they came from a distance,—from banks unknown. Supposing this to be really the case, are we not to reciprocate the benefit? How are other banks from whence Ceylon derived the spawn to be kept reforming, if we do not preserve our banks on reciprocal principles. My opinion is, that while some of the spawn is carried to some distance, other portions find prepared beds in the neighbourhood of the old banks. To no other conclusion can we come, if even we only consult Captain Steuart's Maps, on which are inserted the dates of fishing, and the distance of one fished bank from another.

(Signed) E. F. KELAART, M. D.

Arripo, March 1858.

Report on the Natural History of the Pearl Oyster for season 1858-59, *by E. F. KELAART, M. D. F. L. S., Staff Surgeon.*

It was my intention to make my third Report on the Natural History of the Pearl Oyster, a final one, and to present it to the Ceylon Government at the end of the year, or after the fate of the matured Oysters left unfished this year had been ascertained; but finding, since that determination was made, that the exigencies of the Military Medical service, might possibly withdraw me from the scene of my present Zoological researches, sooner than I expected, I have the honor to submit the following Report of my recent investigations.

The Oysters fished this year, at the Cheval Paar Bank, and the Oysters fished in other parts of the Cheval in the years 1857 and 1858, appear to me to have been the product of the same brood of Oysters, though deposited in various seasons of the same year; *i.e.*, that they were derived from the spawn of the same year, and that the general difference of size in the Oysters, is no more than what may be expected in Oysters developed in various periods of the same year, or within one twelve months. The Oysters formed from the spawn deposited in the months of January or February, will *cæteris paribus*, be of larger dimensions than the Oysters developed from spawn deposited in the months of November or December, following. This is very evident in the great difference observed in the various large masses of young Oysters found this year in the Cheval Paar Bank, and which doubtless have been deposited since the Fishery of 1858, when, if these extensive beds of young Oysters had existed, the numerous native divers employed could not have failed to have seen them. These beds were first observed by Mr. Vane, and Captain Duncan of the Colonial Steamer "Pearl," in October 1858, when none of the young Oysters (judging from the shells Mr. Vane sent to me for examination,) could have been more than six or seven months old;—most of them under six months.

The observations made on the shells of the Fisheries of 1857, 1858 and 1859, lead me to infer that the Fishery of 1857 was premature. The same series of observations lead me to conclude, that the last Fishery of the Cheval Paar Oysters, in March 1859, was the latest safe period that Oysters could have been left unfished in this Bank, and that these Oysters could not have been less than seven years old. The general appearance of the shells, their weight, and the characters of the internal soft parts of the Oyster, showed very distinctly to one who has carefully observed the Oysters fished in 1858, that the Oysters of 1859 were older, and near the termination of their life. These external and internal characters will serve for guidance hereafter to all employed in the Pearl Fisheries of Ceylon, and will be faithfully detailed in my final report, or treatise on the Natural History of the Pearl Oyster. In the mean time, I can assure those sceptical of the possibility of the Zoologist determining the age of the Oyster, as the Veterinary Surgeon does the age of the horse, by looking into its mouth, that the age of the Pearl Oyster can only be determined satisfactorily by looking into the contents of its two valves, and remarking the characters of the internal parts, and their relative position in different periods of their life. I am only waiting for some more information on this head, before full particulars are laid before

Government. In such an important matter, a Zoologist cannot be too cautious in giving an opinion, which, if found hereafter to be erroneous, may not only affect his reputation, but likewise make the Ceylon Government a pecuniary loser. It is my object and wish, to give, at the conclusion of my labors, such rules for the guidance of future Inspectors of Pearl Banks, (who I hope will be intelligent persons, with even a little taste for Natural History,) that the Pearl Banks of Ceylon will have, in future, less chance of being prematurely or over-fished.

From information conveyed to me by Mr. Worsley (the late Inspector) and the English divers employed under him, I find that I was quite correct in stating, in my former Reports, that the rude and rough process of native diving caused the destruction of the old Oysters. No old Oyster was found in that part of the Cheval Paar Bank fished in 1857 and 1858, and as there were many Oysters left there at the end of those fisheries, (though not in aggregate masses), it is natural to infer, that had they not been disturbed, some of them would have lived as long as Oysters brought up this year, from unfished portions of the same Paar, which doubtless were of the same ages. It follows, therefore, that my proposal to leave portions of Banks unfished, for breeding purposes, is a justifiable one, and of great practical importance. From the prevalence of Cholera, the Fishery of 1858 was abruptly stopped, consequently, large masses of Oysters were left unfished in portions on which divers had not worked. How large this quantity, so fortunately reserved, must have been, can be imagined, when it afforded a revenue the following year of upwards of £19,000.

I have no doubt in my own mind, that the myriads of young Oysters now found in the Cheval Paar, were formed from the spawn of these reserved Oysters. He would, indeed, be a bold Naturalist, who, in order to establish a favorite theory, would maintain, that the spawn floating about the sea and derived from banks far off, found a resting place last year on the Cheval Paar, when he finds, contrary to former observations, that the majority of the old Oysters were covered this year with young ones of from four to twelve months growth, and that few of the old Oysters examined had eggs in their ovaries or genital glands. At the end of the Fishery of 1858, the Oysters on all the Banks were in a most favorable condition for the multiplication of species and replenishing the seas. The ovaries of all the thousands of Oysters, examined by me, were full of spawn or spermatozoa.

Owing to the re-appearance of Cholera this year also, a very large quantity of matured Oysters full of eggs were left unfished in the Modregam Bank, and it is to be hoped, that no unforeseen or untoward circumstance will prevent the spawn of these Oysters being deposited in or near the already known banks. Whether the Divers detect this expected new brood or not, the Ceylon Government may feel assured, that the product of the spawn will not be very far off the present Modregam; at all events, it will be a very satisfactory result, if these Oysters too, after performing their natural functions, yield next year a Revenue of £20,000. Had Cholera not prevailed, this amount would probably have been added to the already collected Revenue, but then the millions of young Oysters which the old ones are likely to have produced, would have been lost. Now, there is a very fair prospect of not only securing the value of the old Oysters, but a new generation of the species for future years, when this Colony may be more in want of money than at present.

The future prospects of the Pearl Oyster Banks are very brilliant indeed, although the fisheries (after the probable one of next year), are not likely to be resumed before the year 1864.* It does not appear on record, that such numerous and extensive deposits of young Oysters were ever known to exist, in almost one continuous layer, as the two intelligent and skilful English Divers have discovered this year on the banks of Arripo. There were few Oysters fished this year on the Cheval Paar, that had not from ten to twenty or more young Oysters attached to their upper shells. On one *Pinna* (fan shell) I counted as many as sixty, and on one piece of coral, about two feet in circumference, there were at least 300 one year old Oysters. At the lowest calculation, the quantity of young Oysters now on the Cheval and Modregam Banks, according to the Reports made by the Divers, cannot be less than fifty times

* There may be a fishery near the Modregam in 1863 of Oysters found by Captain Higgs in 1858.

Fort St George

as many as were fished during the last three fisheries. If then, even half this number arrive at maturity, and reach the age of six or seven years, the revenue that will be derived from this source, (if present prices are maintained), will be more than sufficient to pay the cost of the Ceylon Railway. But I shall not be performing my duty as Naturalist, If I do not also place before the Ceylon Government the dark side of this bright future. The mortality among Oysters, from natural and violent causes, is very great, as has been observed in small banks in Trincomalie harbour. Scarcely half of them reach the third year. The ratio of mortality decreases after that, and among older Oysters it is probably not more than five or six per cent. per annum, until they arrive at the last year of their existence, when they die off very rapidly. So that it cannot be expected that more than a fourth or fifth of the young Oysters discovered this year on the banks of Arripo, will live to maturity, or to the age fit for fishing. Even this is a good prospect for the future, but there are other causes which may operate in diminishing this number. Oysters, particularly the young, are liable to be smothered by sand. Although the Divers report that there is scarcely any ground current on the banks, there is reason to believe, that at some seasons the force of water is increased, and that Oyster banks may be partially covered over by sand or sea mud. I have no doubt in my own mind, that the sudden disappearance of young Oysters from banks, is owing, sometimes, to these sand or mud deposits. I have seen the fatal effects of even a few inches of sand on my artificial beds in shallow water; and that such deposits will kill even old Oysters, is evident, as I have ascertained that they cannot live for more than a day or two when thus covered. That such sudden deaths do occur on the Pearl Banks of Arrippo is more than probable, from the fact that the Divers frequently bring up large quantities of dead Oyster shells, of all sizes, from parts of the sea where no living ones were found the year before; and, sometimes, when I have asked for sand or mud, they brought up Oyster shells with it. The natural inference follows, that living Oysters were at one time buried under the sand, and that subsequently, the sand being washed away, the shells were left exposed. This I have observed in the harbour of Trincomalie, where some clusters of Oysters that I translated had disappeared, but in a few months their shells were discovered on the spot where they had lived.

Recent observations corroborate the statement I have previously made, that Pearl Oysters exert their locomotive powers frequently, and that in the act of doing so, they may be washed away to some distance, while their progress is only arrested by meeting with impediments, such as a stony surface or shell, and that there, after a time, they refix themselves by forming new beards. One of the reasons for the Oyster casting off its beard, is, doubtless, that it may form a longer one more suited to its enlarged body. If we consider that the beard (fibres so-called) when once formed, does not grow longer or thicker, the fact is of importance to the Naturalist, who first maintained that Oysters change their position by casting off their old beards or cables, and forming new ones. In an old Oyster a young beard is not found.

A deficiency of hard substances on which the Oyster can re-attach itself, must sometimes occur, from either a natural scarcity of coral, stones, or shells; or from these substances being covered over for a time with sand. This probably is also a temporary hindrance to the formation of new banks. Taking all these well ascertained circumstances, and also the probable ones, into consideration, I have to propose to the Ceylon Government, not only the adoption of Monsieur Coste's plan of placing fascines on Oyster beds, for the collection of the spawn, but that a barrier be placed round each bank, in order to prevent the Oysters from being forced away by currents or other causes, to regions unknown.

That young Oysters will attach themselves to any hard substances placed in the sea, cannot be doubted. An iron boat anchor accidentally dropped over-board during the Fishery of 1857, was brought up this year by one of the English Divers, covered with young Oysters; and in my experiments at Trincomalie, I found that even very old Oysters will reform their beards and refix themselves to old shells, wood, iron, coir matting, zinc plates, cocoanut shells, chatties, &c. The piles supporting the piers in the harbour are covered with young edible Oysters. We have

thus every encouragement for the adoption of the method I beg to suggest, for the future conservation of the Pearl Banks of Ceylon and India.

The plan proposed, is, to girdle or barricade the Oyster Banks with coir matting supported on iron frames, and placed round each bank about ten yards beyond the edge of the Oyster bed; fascines, dead Oyster shells, corals, &c. being deposited between the barricade and the edge of bank. The interspace will allow of sufficient room for the roaming disposition of the Oysters; and the impediments thrown in their way will give new surfaces for their attachment, while at the same time they will form a sufficient barrier to prevent the Oysters escaping to distant parts of the sea, where they would not readily, if ever, be found again. This barricade of coir and iron, with the fascines, will also attract and fix any spawn that may be floating about. I placed, last year, with the aid of the English Divers, a few wicker-work and coir fascines, or rather cages, on both banks, and I shall be very glad to have their condition examined and reported upon by the Divers, after their next inspection of the banks.

It will be of little value to carry on any experiments of the above kind in Trincomalie harbour, for the nature of the Arripo banks is very different, and the influences of the sea on the two banks are not the same; I have, therefore, to propose, that before Government decides upon my plan, a fair trial of it be made in one of the Arripo banks; say, even on one of those large scattered masses of young Oysters near the large banks:—a trial of six or twelve months will perhaps be sufficient to test its value. I hope to be able, before the next inspection takes place, to show personally to His Excellency the Governor, or to any authorized person, the kind of barricade and fascines I have proposed.

Before concluding this Report, I have another proposal to submit for the better preservation of Oyster beds.

It is now quite established, that young Oysters will live after being once removed from the sea. I had the pleasure of exhibiting to His Excellency the Governor, when he visited Arripo during the last fishery, a quantity of young Oysters living attached to a glass vivarium. These I had picked up at the *Cootloos*, after they had been out of water for more than four or five hours. It is therefore, more than probable, that young Oysters detached from the old ones during a fishery, if properly cared for and translated to some favorable parts of the sea, will live and grow to perfection. But, to do this satisfactorily, there must be some well organized system adopted in future. It was lamentable to see the myriads of young Oysters committed to almost certain destruction by the divers throwing them over-board immediately under the boats, and in the very places where the diving stones were crushing and bruising the delicate creatures. On my representing the matter to His Excellency the Governor and to Mr. Vane, the divers were ordered to desist from this cruel and destructive practice, and to collect the young Oysters (of which I should say that there were more than two millions brought up daily from the Cheval Paar bank), and after the day's fishing to deposit them in a part of the sea, (previously buoyed out by the Inspector,) as the boats were leaving the banks. From the want of proper Officers to see this order carried out, I fear many hundreds of thousands of young Oysters met with an untimely end. To avoid this in future, I would suggest, that every preparation be made beforehand, for the safe removal of the young Oysters, whenever they are found to be attached to old ones brought up by the divers. Let each diving boat be provided with a large basket suspended in the sea from the side or stern of the boat, and let strict injunctions be given, and the divers compelled, carefully to remove the young Oysters from the old, and place them in these baskets, which can be emptied into any part of the sea previously selected by the Inspector. Or let boats be employed during the diving to collect the Oysters for deposit elsewhere.

For the better security of these young Oysters, let the part selected for the formation of a new bed be surrounded with coir matted fascines; and let the part so selected be ascertained to have a large quantity of coral and dead shells, that the young Oysters may not be forced away from the spot owing to the want of holding ground.

In conclusion, I beg to observe, that although my plans may appear chimerical, especially the one of girdling or barricading banks in 6 or 7 fathoms of water, it will not appear to be so

impracticable, if the services of the English Divers now in the Island are made available for the purpose. Nothing of this kind should seem impossible to a nation that can lay down wire cables across the Atlantic or in the beds of the Red Sea and Persian Gulf. The expense likely to be incurred is very trifling, compared with the value of the Oysters that may be preserved. The present market value of a bed of Pearl Oysters, two miles in circumference, is, say, from £30 to £40,000, and the expense of fencing a bed of this size cannot be more than £200, or say £300. If then the experiment I have proposed should prove successful, such an outlay is too small to deter any Government from undertaking the work on a greater scale. I hope that the presence of young Oysters in such large quantities on the Pearl Banks of Arripo, will not make the Government less anxious about the better conservation of the banks. Who can tell what may happen during the next four or five years?—that many of the Oysters will die a natural death, and that many more will be used as food by thousands of voracious marine animals, in the interim, is a certainty; but we should not forget that there is a probability of whole masses being carried away from other causes. What may now appear likely to yield a revenue of many hundred thousands, may not produce more than a few thousands at the end of five or six years. It is time, now that the Emperor of France has acted upon the suggestion of a French Naturalist, and thereby increased the production of the edible Oysters of France, that the Ceylon Government should treat the Pearl Oyster with more care and consideration than it has hitherto done, so that the profits derived from this source may become a permanent or less fluctuating revenue; and that the plan proposed by their Naturalist should be at least fairly tried, even on a small scale, before any decision adverse to it be adopted.

I have not in this paper detailed some very interesting discoveries made since my last Report, on the Anatomy and Physiology of the Pearl Oyster, believing that they are better fitted for a treatise on the subject, than to be embodied in a report to the Ceylon Government, which must necessarily be written in a popular form. However, as this Report may, like the preceding ones, fall into the hands of scientific men, I shall merely mention here, that Monsieur Humbert, a Swiss Zoologist, has, by his own microscopic observations at the last Pearl Fishery, corroborated all I have stated about the ovaria or genital glands and their contents; and that he has discovered in addition to the Filaria and Circaria, three other parasitical worms infesting the viscera and other parts of the Pearl Oyster. We both agree that these worms play an important part in the formation of Pearls; and it may yet be found possible to infect Oysters in other beds with these worms, and thus increase the quantity of these gems. The nucleus of an American pearl drawn by Mobius, is nearly of the same form as the Circaria found in the Pearl Oysters of Ceylon. It will be curious to ascertain, if the Oysters in the Tinnevelly Banks have the same species of worms as those found in the Oysters on the banks at Arripo.

Trincomalie.
Fort Frederick, 13th July 1859.

E. F. KELAART, M. D.

No. 253. ORDER THEREON, 17th February 1864, No. 288.

Ordered that the said reports be re-printed for distribution in this Presidency.

(True Extract.)

(Signed) J. D. SIM,
Secretary to Government.

To the Board of Revenue.

Exd. S. T. Augustin.

N°. 4

Colonial Secretary's Office
Colombo 30th January 1860.

Sir,

Having laid before His Honor the Officer Administering the Government your No. 95 A of the 14th instant, I am directed to acquaint you that there is no objection on the part of this Government to Dr. Kelaart's reports being reprinted for distribution in the Madras Presidency

I have the honor to be, Sir,
Your most obedt. Servant
James Swan

The Chief Secretary
to Government
Fort St George

No. 288.

Ordered that the said reports be reprinted for distribution in the Madras Presidency.

Fort St. George
17th Feby. 1864.

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Pro: of Govt for February.
No. 365.

From the Colonial Secty at Colombo.

Dated 30th Jany.
Received 9th Feby. 1864.
No. 4

Intimating that there is no objection to Dr Kelaart's reports on Pearl fishery being printed for distribution in the Madras Presidency.

No. 288. 17th Feb.